CLAIMS

1. A purification material for removing a contaminant from an impure hydride gas comprising

(a) an adsorbent comprising a reduced metal oxide on a porous support; and

(b) a desiccant.

2. The purification material of Claim 1 wherein the porous support is selected from the group consisting of activated carbon, alumina, silica, zeolite, silica alumina, titania, zirconia, and combinations thereof.

3. The purification material of Claim 2 wherein the porous support is activated carbon.

4. The purification material of Claim 1 wherein the reduced metal oxide comprises one or more metals selected from the group consisting of Group I alkali metals (lithium, sodium, potassium, rubidium, and cesium), Group II alkaline earth metals (magnesium, calcium, strontium, and barium), and transition metals (manganese, nickel, zinc, iron, molybdenum, tungsten, titanium, vanadium, cobalt, and rhodium).

5. The purification material of Claim 1 wherein the desiccant is selected from the group consisting of hygroscopic metal salts, zeolites, single metal oxides, mixed metal oxides, and combinations thereof.

6. The purification material of Claim 1 wherein the adsorbent and the desiccant are combined by (1) mixing the adsorbent with the desiccant to provide a mixed purification material or (2) forming layers of adsorbent and the desiccant to provide a layered purification material.

7. The purification material of Claim 1 wherein the adsorbent has a surface area in the range of about is in the range of about 250 to about 1200 m^2/g.

8. A method of making a purification material for the removal a contaminant from an impure hydride gas comprising

(a) dissolving one or more metal salts in a solvent to provide a metal salt solution;

(b) contacting a porous support with the metal salt solution to provide an impregnated porous support;

(c) heating the impregnated porous support to remove excess solvent and decompose the metal salt to a metal oxide, thereby providing a metal oxide deposited on a porous support;

(d) heating the metal oxide deposited on the porous support in a reducing atmosphere to provide a reduced metal oxide on the porous support, and cooling the metal oxide to yield a reduced metal oxide adsorbent material; and

(e) combining the reduced metal oxide adsorbent material with a desiccant material to provide the purification material for the removal of contaminants from hydride gases.

9. The method of Claim 8 wherein the porous support is selected from the group consisting of activated carbon, alumina, silica, zeolite, silica alumina, titania, zirconia, and combinations thereof.

10. The method of Claim 8 wherein the reduced metal oxide comprises one or more metals selected from the group consisting of Group I alkali metals (lithium, sodium, potassium, rubidium, and cesium), Group II alkaline earth metals (magnesium, calcium, strontium, and barium), and transition metals (manganese, nickel, zinc, iron, molybdenum, tungsten, titanium, vanadium, cobalt, and rhodium).

11. The method of Claim 8 wherein the desiccant is selected from the group consisting of hygroscopic metal salts, zeolites, single metal oxides, mixed metal oxides, and combinations thereof.

12. The method of Claim 8 wherein the reduced metal oxide adsorbent material and the desiccant are combined by (1) mixing the reduced metal oxide adsorbent material with the desiccant to provide a mixed purification material or (2) forming layers of the reduced metal oxide adsorbent material and the desiccant to provide a layered purification material.

13. The method of Claim 8 wherein the reduced metal oxide adsorbent material has a surface area in the range of about 250 to about 1200 m^2/g.

14. A method of making a purification material for the removal of a contaminant from an impure hydride gas comprising

(a) dissolving one or more metal salts in a solvent to provide a metal salt solution;

(b) contacting the metal salt solution with an activated carbon support to provide an impregnated activated carbon support;

(c) heating the impregnated porous support to remove excess solvent and decompose the metal salt to a metal oxide, thereby providing a metal oxide deposited on an activated carbon support;

(d) heating the metal oxide deposited on the activated carbon support to provide a reduced metal oxide on the activated carbon support, and cooling the metal oxide to yield a reduced metal oxide adsorbent material; and

(e) combining the reduced metal oxide adsorbent material with a desiccant material to provide the purification material.

15. The method of Claim 14 wherein the heating of the metal oxide deposited on the activated carbon support is effected at an operating condition selected from the group consisting of (1) evacuating gas from the metal oxide deposited on the activated carbon support, (2) contacting the metal oxide deposited on the activated carbon with an inert atmosphere, and (3) contacting the metal oxide deposited on the activated carbon with a reducing atmosphere.

16. The method of Claim 15 wherein the reduced metal oxide comprises one or more metals selected from the group consisting of Group I alkali metals (lithium, sodium, potassium, rubidium, and cesium), Group II alkaline earth metals (magnesium, calcium, strontium, and barium), and transition metals (manganese, nickel, zinc, iron, molybdenum, tungsten, titanium, vanadium, cobalt, and rhodium).

17. The method of Claim 15 wherein the desiccant is selected from the group consisting of hygroscopic metal salts, zeolites, single metal oxides, mixed metal oxides, and combinations thereof.

18. The method of Claim 15 wherein the reduced metal oxide adsorbent material and the desiccant are combined by (1) mixing the reduced metal oxide adsorbent material with the desiccant to provide a mixed purification material or (2) forming layers of the reduced metal oxide adsorbent material and the desiccant to provide a layered purification material.

19. A method for purifying a hydride gas containing at least one contaminant, which method comprises

(a) providing a purification material comprising (1) an adsorbent comprising a reduced metal oxide on a porous support and (2) a desiccant;

(b) contacting the hydride gas with the purification material to remove at least a portion of the contaminant; and

(c) separating the hydride gas from the purification material to provide a purified hydride gas and a spent purification material.

20. The method of Claim 19 wherein the porous support is selected from the group consisting of activated carbon, alumina, silica, zeolite, silica alumina, titania, zirconia, and combinations thereof.

21. The method of Claim 19 wherein the reduced metal oxide comprises one or more metals selected from the group consisting of Group I alkali metals (lithium, sodium, potassium, rubidium, and cesium), Group II alkaline earth metals (magnesium, calcium, strontium, and barium), and transition metals (manganese, nickel, zinc, iron, molybdenum, tungsten, titanium, vanadium, cobalt, and rhodium).

22. The method of Claim 19 wherein the desiccant is selected from the group consisting of hygroscopic metal salts, zeolites, single metal oxides, mixed metal oxides, and combinations thereof.

23. The method of Claim 19 wherein the adsorbent and the desiccant are combined by (1) mixing the adsorbent with the desiccant to provide a mixed purification material or (2) forming layers of the adsorbent and the desiccant to provide a layered purification material.

24. The method of Claim 19 wherein adsorbent has a surface area in the range of about 250 to about 1200 m^2/g.

25. The method of Claim 19 wherein the at least one contaminant is selected from the group consisting of oxygen, carbon dioxide, and water.

26. The method of Claim 19 wherein the purification material is provided by

(a) dissolving one or more metal salts in a solvent to provide a metal salt solution;

(b) contacting a porous support with the metal salt solution to provide an impregnated porous support;

(c) heating the impregnated porous support to remove excess solvent and decompose the metal salt to a metal oxide, thereby providing a metal oxide deposited on a porous support;

(d) heating the metal oxide deposited on the porous support in a reducing atmosphere to provide a reduced metal oxide on the porous support, and cooling the metal oxide to yield a reduced metal oxide adsorbent material; and

(e) combining the reduced metal oxide adsorbent material with a desiccant material to provide the purification material.

27. The method of Claim 26 wherein the spent purification material is regenerated by heating in a reducing atmosphere.

28. The method of Claim 19 wherein the purification material is provided by

(a) dissolving one or more metal salts in a solvent to provide a metal salt solution;

(b) contacting the metal salt solution with an activated carbon support to provide an impregnated activated carbon support;

(c) heating the impregnated activated carbon support to remove excess solvent and decompose the metal salt to a metal oxide, thereby providing a metal oxide deposited on an activated carbon support;

(d) heating the metal oxide deposited on the activated carbon support to provide a reduced metal oxide on the activated carbon support, and cooling the metal oxide to yield a reduced metal oxide adsorbent material; and

(e) combining the reduced metal oxide adsorbent material with a desiccant material to provide the purification material.

29. The method of Claim 28 wherein the spent purification material is regenerated by heating in combination with an operating condition selected from the group consisting of (1) evacuating gas from the spent purification material, (2) contacting the spent purification material with an inert atmosphere, and (3) contacting the spent purification material with a reducing atmosphere.

30. The method of Claim 19 wherein the hydride gas is selected from the group consisting of hydrogen, ammonia, arsine, phosphine, germane, silane, disilane, diborane, and alkyl or halide derivatives thereof.

31. The method of Claim 19 wherein the at least one contaminant is selected from the group consisting of oxygen, carbon dioxide, and water.

32. A purified hydride gas produced by the method comprising

(a) providing a purification material comprising (1) an adsorbent comprising a reduced metal oxide on a porous support and (2) a desiccant;

(b) providing a contaminated hydride gas containing at least one contaminant;

(c) contacting the contaminated hydride gas with the purification material to remove at least a portion of the contaminant; and

(d) separating the hydride gas from the purification material to provide a purified hydride gas and a spent purification material.

33. The method of Claim 32 wherein the hydride gas is selected from the group consisting of hydrogen, ammonia, arsine, phosphine, germane, silane, disilane, diborane, and alkyl or halide derivatives thereof.

34. The method of Claim 32 wherein the at least one contaminant is selected from the group consisting of oxygen, carbon dioxide, and water.

35. The method of Claim 32 wherein the adsorbent has surface area in the range of about 250 to about 1200 m^2/g.